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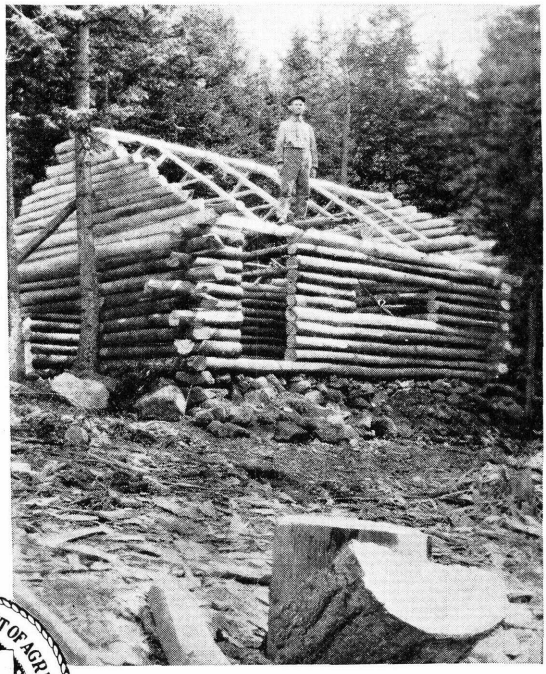
PROTECTION

OF LOG CABINS, RUSTIC WORK AND UNSEASONED WOOD *from* INJURIOUS INSECTS



INSECTS cause considerable damage to the unbarked logs of the principal woods used in the construction of log cabins, rustic woodwork, and certain other unseasoned products. This damage, which varies from the making of numerous holes in the bark to the complete destruction of the sapwood and heartwood, causes annoyance and unsightly condition of the material as well as large financial loss. Some of the insects which cause the damage are active nearly every month of the year except December, January, and February. It has been found that by cutting the trees at certain seasons and by treating the wood with preventive and remedial substances practically all such insect damage can be prevented or checked. This bulletin tells how it can be done.

Although the information contained herein applies specifically to the insects which occur in the eastern and southern parts of the United States, the principles set forth can be applied equally well to problems of this nature which occur in the country as a whole, provided due allowance is made for individual differences in insect and tree species and also in the time of flight of the beetles because of differences in climate.

Washington, D. C.

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PROTECTION OF LOG CABINS, RUSTIC WORK, AND UNSEASONED WOOD FROM INJURIOUS INSECTS

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DURING the last few years there has been an increasing demand for information on the protection of log cabins and rustic work from injurious insects. This is largely due to the popularizing of National and State forests and parks for recreational purposes, as a result of which many rustic bridges, benches, and log cabins have been constructed in such places. But it is also due to the increased building of rustic summer homes and arbors on private woodlands and estates. Wood with the bark still on is subject to injury by many kinds of beetles; therefore manufacturers, as well as the users, of rustic furniture constantly request advice. In addition, concerns requiring small raw poles from which to manufacture certain finished products, such as shuttle blocks, mallets, and mauls, often suffer severe losses and call for advice.

HOW BEETLES AND GRUBS DAMAGE UNSEASONED WOOD

Woods cut at certain seasons of the year are subject to attack by beetles which fill the bark with holes, thus causing sawdustlike borings to fall out and lodge on the wood. The larvae, or grubs, of wood-boring beetles mine the inner bark, causing the bark to loosen and fall off, and they bore into the sapwood and sometimes the heartwood of logs, making large holes and often reducing them almost to dust within a few months, before the wood becomes well seasoned.

WOODS PRINCIPALLY USED FOR CABINS, RUSTIC WORK, AND CERTAIN WOOD PRODUCTS

The woods mainly used in the construction [a] of log cabins and the rustic work in summer homes, furniture, and fences are spruce, fir,

[a] For information on methods of construction, consult MILLER, T. A. H. THE USE OF LOGS AND POLES IN FARM CONSTRUCTION. U. S. Dept. Agr. Farmers' Bul. 1660, 26 pp., illus. 1931. [Slightly revised 1935.] Also HUNT, GEORGE M. MAKING LOG CABINS ENDURE. Amer. Forests 39: 265, 287, illus. 1933.

hemlock, tamarack, cedar, juniper, pine, cypress, birch, poplar, willow, hickory, and oak.

The selection of wood to be used for these purposes is often determined to a large extent by the local supply. Hickory, ash, dogwood, and persimmon, used in the manufacture of shuttle blocks, mallets, mauls, etc., are cut under similar conditions and thus are subject to similar attack, and protective measures described in this bulletin are equally applicable to stock cut for such purposes. Those woods which are probably most subject to insect attack and damage, if cut during certain seasons of the year as explained on pages 14 and 15, are hickory, pine, persimmon, spruce, ash, and dogwood, although the others mentioned are by no means immune. The damage can be largely prevented by proper measures.

From the standpoint of durability, cedar, juniper, and white oak are probably the most desirable of the woods listed above, especially where the wood comes in contact with the ground. Other woods, such as birch, poplar, and willow, are relatively short lived.[1]

CLASSES OF INSECTS RESPONSIBLE AND THE DAMAGE THEY DO

The insects responsible for damage, in cases where the bark remains on logs used in rustic work, can be conveniently grouped into three main types or classes, according to their structure and the character of their work, namely, bark beetles,[2] ambrosia beetles,[2] and wood borers.[3] The bark beetles confine their activities to the bark and burrow between it and the sapwood, often scoring the latter; the ambrosia beetles bore directly through the bark into the sapwood and sometimes the heartwood, and the wood borers may penetrate all three parts of the log.

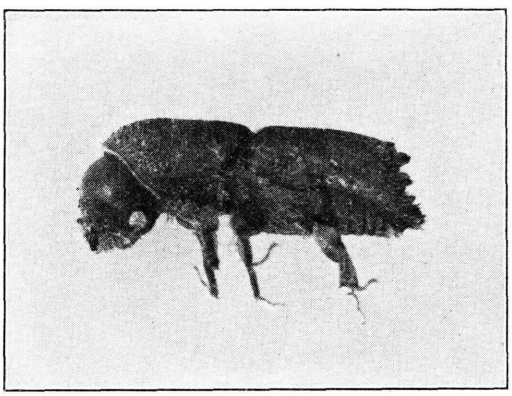

FIGURE 1.—An adult bark beetle, *Ips avulsus* (Eich.). Enlarged 18 diameters.

All three classes of these insects have four distinct stages, namely, the egg; the larva, also called worm or grub; the pupa, or transforming stage; and the adult, or beetle stage. Only the larval and adult stages are responsible for damage to woodwork.

In all instances the larvae hatch from eggs laid by the beetles. After the larva becomes mature it makes a cell in which to rest, called the pupal cell, and there becomes a beetle.

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[1] The United States Forest Service has conducted extensive tests and made detailed studies of the durability and chemical preservation of wood and should be consulted if further information of this character is desired.

[2] Order Coleoptera, family Scolytidae.

[3] Order Coleoptera, families Cerambycidae, Bostrichidae, and Buprestidae.

BARK BEETLES

The adult insects of the first class, the bark beetles, are short, cylindrical, reddish-brown to black insects, varying in length from about one-sixteenth to one-fourth inch (fig. 1). They bore through the outer bark to its soft inner portion, called the phloem, where they make tunnels of various types, along the sides of which they lay their eggs (fig. 2). It is while the beetles are boring through the

FIGURE 2.—Tunnels of adults and larval galleries of a bark beetle, *Leperisinus aculeatus* (Say), beneath the bark of ash. Natural size. The frass that was in the galleries of this species adhered to the bark when it was removed.

bark and constructing their tunnels that they push out to the entrances the fine brownish-white sawdustlike particles, or frass, which falls on the wood below and attracts attention by its unsightly appearance, and it is this tunneling that causes the bark to loosen and fall off. The piles of frass on a log enable one readily to detect the presence of bark beetles within it. The larvae or grubs are tiny, whitish, cylindrical, slightly curved, legless creatures (fig. 3). Upon hatching

from the eggs, they extend their mines in all directions, quite often at right angles to the original (parent) tunnel, thereby aiding in the loosening of the bark. The galleries often contain borings or frass. This depends upon the species of bark beetle.

AMBROSIA BEETLES

The ambrosia beetles (fig. 4) or pinhole borers, which are the adults of the second class, closely resemble the bark beetles in general appearance. Their work differs considerably, however, and can easily be distinguished. After the ambrosia beetles enter the bark they bore immediately into the sapwood and sometimes into the heartwood, where they extend their galleries in all directions, each making a hole about the size of a pinhead (fig. 5). While boring these tunnels they push out sawdustlike particles, which either fall out loosely in piles (fig. 6), or come out in stringlike masses (fig. 7) as if being squeezed from a tube. These borings are white, whereas those of the bark beetles are usually brownish and fall losely from the holes in the bark, although in certain cases much of it remains in the tunnels. The galleries of the ambrosia beetles are round, always free from borings, and quite often their walls are stained black.

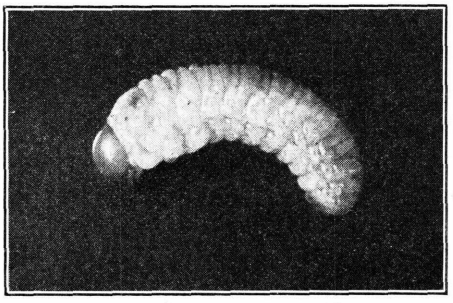

FIGURE 3.—Larva or grub of a pine bark beetle (*Ips* sp.). Enlarged 10 diameters.

Their food is not the wood, but a substance called "ambrosia," which is a coating formed of a minute fungus that is propagated by the beetles themselves. It is this that stains the walls of their galleries.[4] The damage by these borers is caused almost entirely by the adult beetles, as the larvae until mature, stay either in the original gallery or in separate cells where they are in most cases cared for and fed by the beetles.

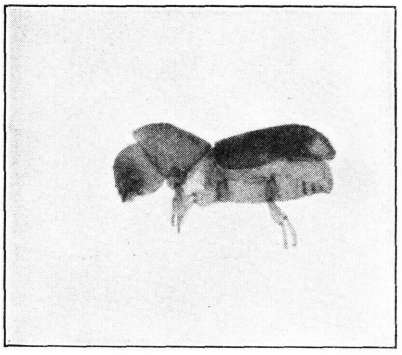

FIGURE 4.—An adult ambrosia beetle (*Xyleborus* sp.). Enlarged about 14 diameters.

Beetles of this group do not often cause much damage to wood after it has been put into log cabins or rustic work if the trees are cut in the fall of the year, because then it has seasoned by the time the beetles are flying and is too dry to be in a suitable condition for them to work in it. If the wood is cut green, however, and is used during the period of insect activity, it may be attacked immediately by the beetles, in which case a considerable quantity of boring dust will be exuded.

[4] HUBBARD, H. G. AMBROSIA BEETLES. U. S. Dept. Agr. Yearbook 1896: 421–430, illus. 1897.

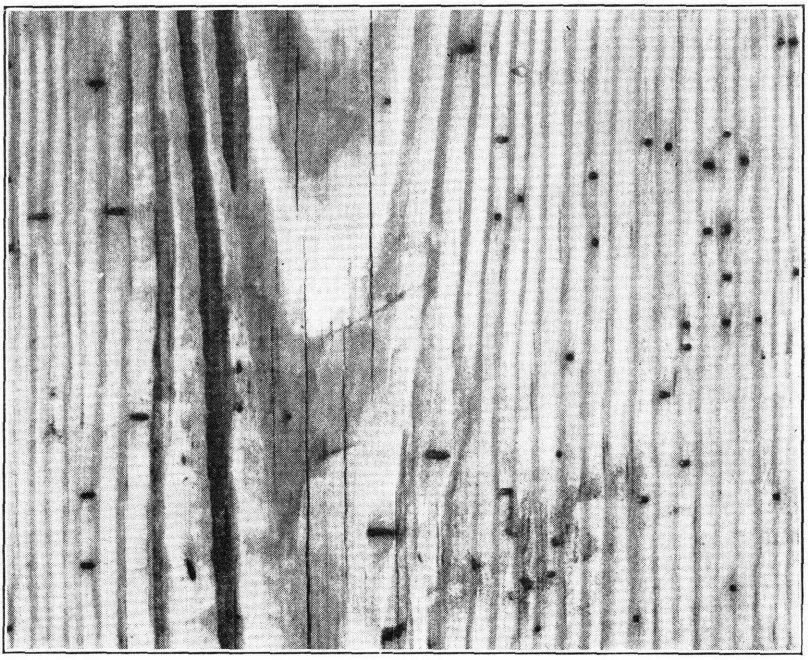

FIGURE 5.—Work of adult ambrosia beetles (*Xyloterinus politus* (Say)) in pine. Two-thirds natural size.

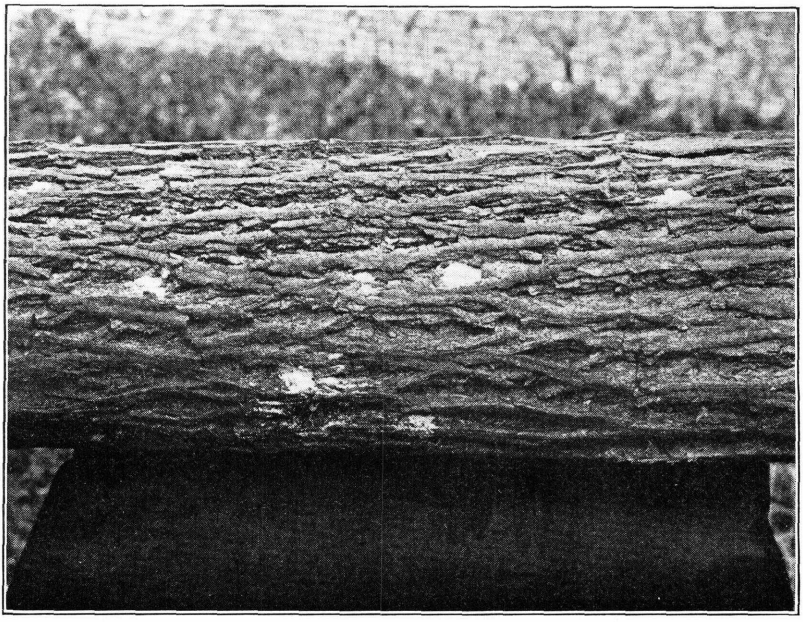

FIGURE 6.—Piles of boring dust or frass being pushed out as ambrosia beetles (*Monarthrum* sp.) are entering a hickory log. About one-third natural size.

WOOD BORERS

The adults of the wood borers do not as a group present so uniform an appearance as do the bark beetles and ambrosia beetles. The wood borers may be divided into three subgroups, namely, powder-post beetles, roundhead borers, and flat-headed borers.

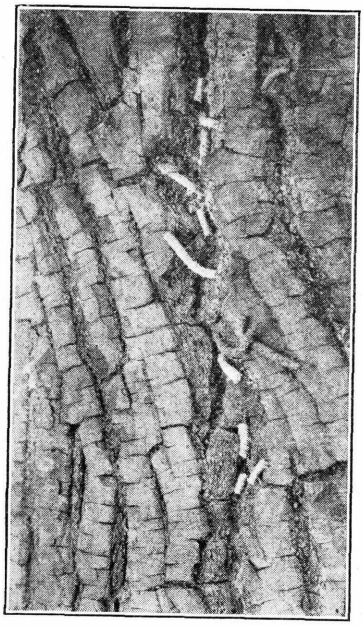

FIGURE 7.—Boring dust or frass which certain ambrosia beetles (*Xyloterinus politus* (Say)) push out of the wood in cylindrical casts. About natural size.

POWDER-POST BEETLES

The powder-post beetles are short, cylindrical reddish-brown to black, hard-shelled insects, ranging in length from one-eighth to nearly one-half inch.

In the eastern section of the United States there is only one species [5] that causes much damage to the class of materials under consideration. This beetle has reddish-brown markings and is about one-fourth of an inch long (fig. 8). It is commonly known as the "red-headed shot-hole borer" and was mentioned years ago by C. V. Riley as doing considerable damage. It works principally in the wood of the hickory and persimmon, although it has been found in other woods. The adult bores through the bark and into the sapwood, making a cylindrical tunnel around the log just under the surface of the wood and at right angles to the grain (fig. 9). The pores or cells of the wood are opened up, and the female beetle can then insert her eggs into them. The original or egg tunnel is usually bored about 1½ inches on each side of the entrance hole, although in some cases it may extend in one direction only. The injury can readily be detected by the loose, whitish, dust-like borings which may be found on the bark below the circular entrance hole of the parent gallery.

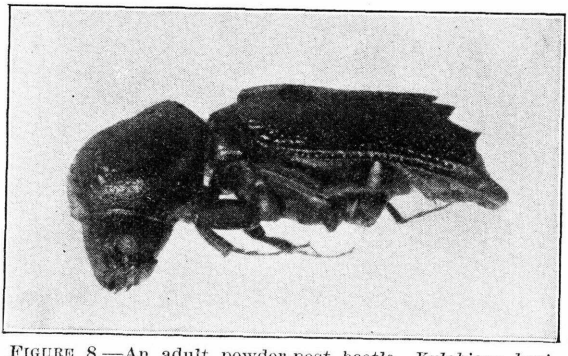

FIGURE 8.—An adult powder-post beetle, *Xylobiops basilaris*. Enlarged 12 diameters.

The larva or grub of this beetle has a curved form, somewhat similar in shape to that of the cutworms found in the garden. When

[5] *Xylobiops basilaris* (Say).

it is doubled up the head of the grub is close to the end of the abdomen (fig. 10). This beetle, in marked contrast to the ambrosia beetles, is exceedingly destructive to the wood, both in its adult and larval stages. In pieces of wood of small diameter it often extends its gallery or tunnel completely around the section, thus greatly weakening it and causing it to break off readily. The larvae also extend their work to the pith in such pieces, completely destroying it and often literally reducing it to powder. In the larger pieces of wood this insect confines its work more to the sapwood, and by the time the larvae are full grown they have destroyed nearly all of the sapwood (fig. 11). The work of the larval borers is entirely in the interior of the log and cannot be detected without chopping into the wood. The borings are of the same texture as those of the adult ambrosia beetles but are packed tightly in the mines behind the larvae. When the borings are loosened they break up into cakes. Occasionally the injury is not noticed until the wood has been worked up into the finished product (fig. 12) and the emerging beetles leave holes that indicate the destruction which has been going on unnoticed inside of the manufactured article.

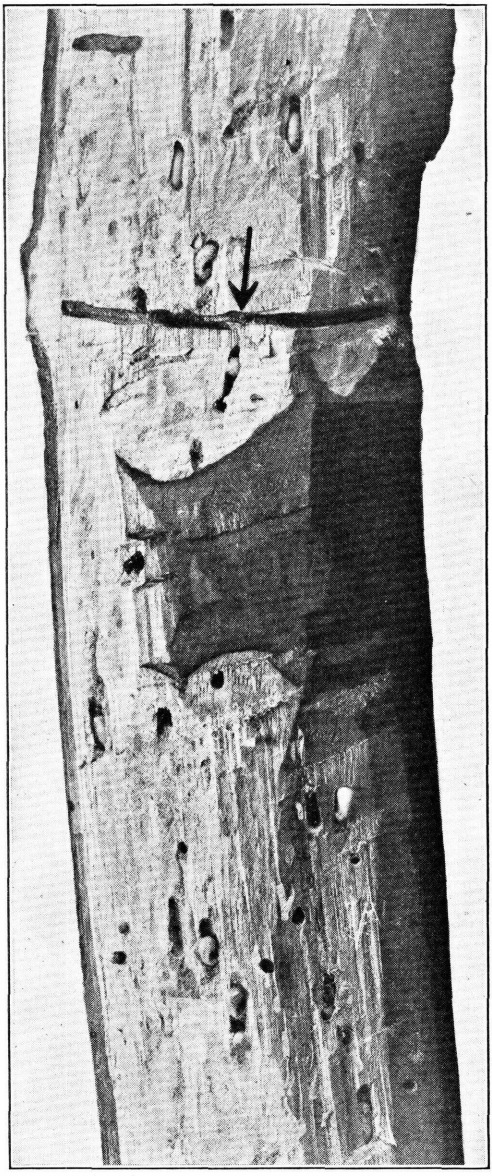

FIGURE 9.—Piece of hickory with the bark and a little of the wood removed, revealing tunnel of an adult powder-post beetle, *Xylobiops basilaris*. Entrance hole is shown at tip of arrow, and the gallery is seen extending on each side. Larvae, pupae, and emerging adults are shown in their cells. Natural size.

Hickory and persimmon woods used in the manufacture of shuttle blocks, mallets, mauls, etc., are liable to severe injury by this insect, sometimes suffering a 50 percent loss (figs. 11 and 12).

ROUNDHEADED BORERS

The roundheaded borers have a remarkable variation in general appearance (fig. 13). The beetles range in length from less than one-fourth inch to more than 1½ inches. They also vary considerably in the place and the manner of laying their eggs. The adult beetles lay their eggs (1) on top of the bark[6] (fig. 14), or (2), if the bark is removed, occasionally on the sapwood, over which they secrete a covering, or (3) in crevices under the bark[7] (fig. 15), or (4) through slits or pits[8] which they gnaw in it (fig. 16).

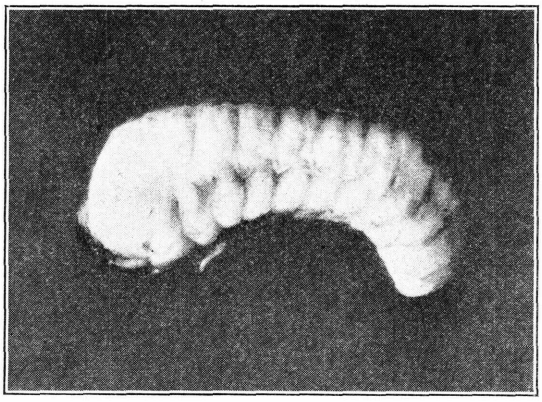

FIGURE 10.—Larva or grub of the powder-post beetle *Xylobiops basilaris*. It is in this stage that it does most of its injurious boring. Enlarged 9 diameters.

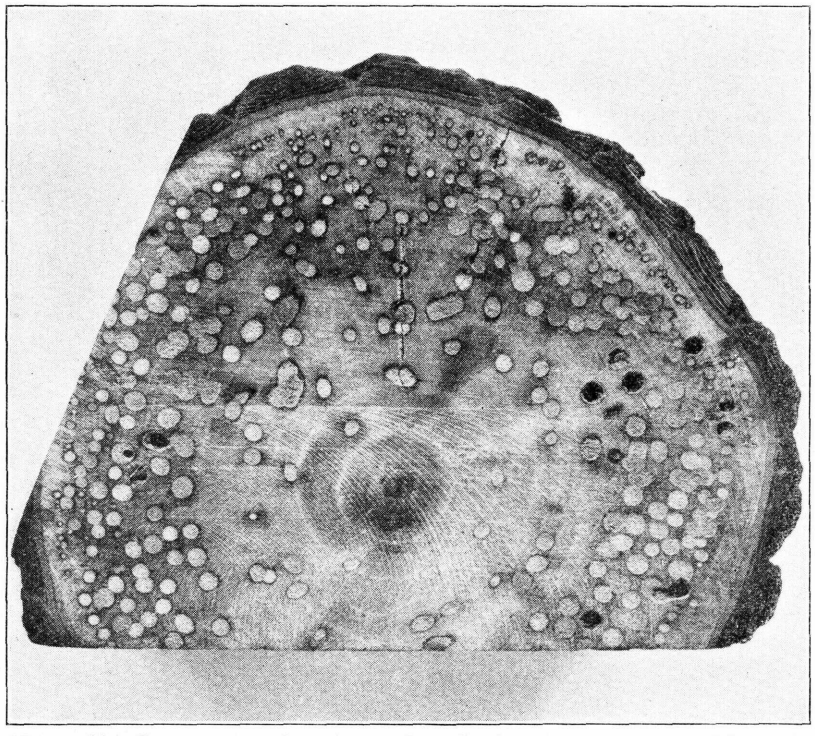

FIGURE 11.—Cross section of persimmon log, showing the wood destroyed by grubs of the powder-post beetle *Xylobiops basilaris*. Natural size.

[6] *Chion cinctus* (Drury).
[7] *Neoclytus* sp., *Cyllene caryae* Gahan, etc.
[8] *Monochamus* sp.

The larvae (fig. 17) which hatch from these eggs are entirely responsible for the damage caused to the wood. They are elongate, fleshy, yellowish-white grubs, usually slightly tapering toward the tail end. Upon hatching, they bore into the soft layers of the inner bark, or phloem, which they begin to mine. Some species [9] confine much of their activity to mining under the bark, thereby loosening it and causing it to fall off, and they also mine in the outer sapwood (fig. 18). Others make large oval mines which extend deeper into the sapwood [10] and heartwood.[11] Sometimes the grubs completely riddle the wood within a few months. As these galleries are often one-half inch wide and as much as 2 feet long, they weaken the material as well as cause an unsightly condition

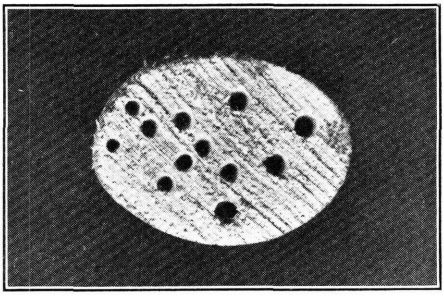

FIGURE 12.—Cross section of hickory handle, showing damage caused by grubs of the powder-post beetle *Xylobiops basilaris*. Some of the tightly packed powderlike borings were removed from near the surface to show more clearly the extent of the damage. About actual size.

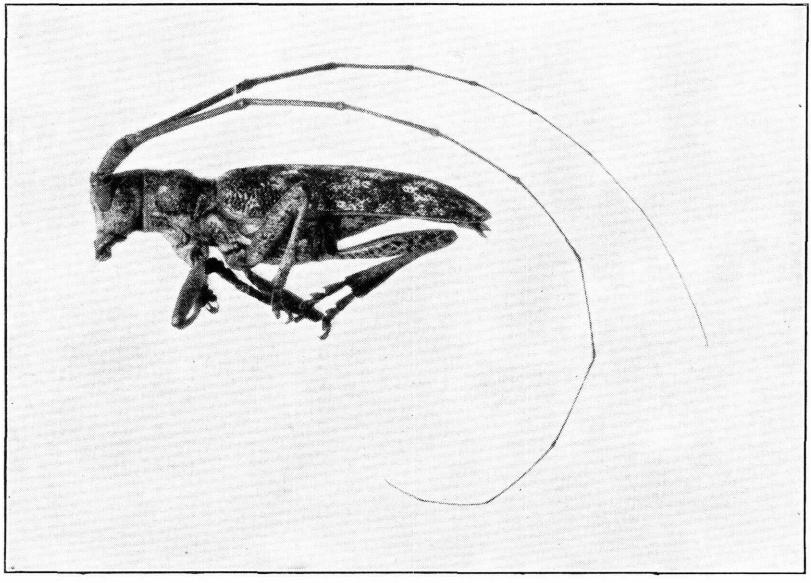

FIGURE 13.—Adult beetle of southern pine sawyer, *Monochamus titillator* (F.). Enlarged 2½ diameters.

because of the large quantity of boring dust which many of the grubs push to the outside during the process of excavation (fig. 19).

[9] *Xylotrechus colonus* (F.) and *Callidium antennatum* Newm.
[10] *Neoclytus* sp., *Monochamus* sp., *Cyllene caryae* Gahan.
[11] *Neoclytus caprea* (Say).

FIGURE 14.—Adult female beetle and egg of *Chion cinctus* on a section of hickory. About natural size.

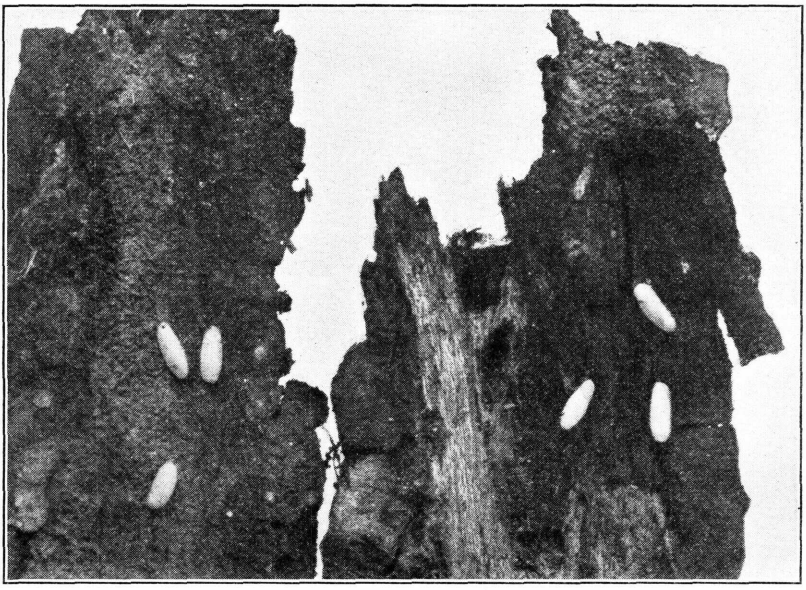

FIGURE 15.—Piece of log with bark removed to show eggs of white painted hickory borer, *Cyllene caryae*, which were inserted through crevices. Enlarged 3½ diameters.

Each species differs somewhat from others in the method of preparing its gallery. Some grubs pack the borings, or frass, tightly behind them (fig. 11), while others push it out through the entrance hole

(fig. 19). The composition of these borings varies from fine, white, and powdery material (fig. 11) to coarse, brownish particles (fig. 19) or shreds of wood fiber (fig. 20). These characters, combined with the species of wood they select to work in, make it possible to determine the type of injury, and in most instances to identify the specific insect responsible for the damage, since each species makes a different pattern while scoring the wood under the bark, or gallery of a different shape or size while working in the wood.

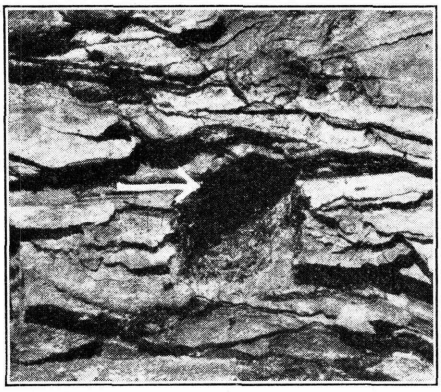

FIGURE 16.—Egg scar made by southern pine sawyer, *Monochamus titillator*, on bark of pine. The eggs are inserted through this opening. About natural size.

FLATHEADED BORERS

The beetles of the group known as flatheaded borers are more uniform in general appearance than are those of the roundheaded borers. They are slightly flattened, metallic-colored, boat-shaped beetles which range in length from one-fourth inch to nearly 1¼ inches (fig. 21).

The eggs are laid singly or in a mass on the bark or in crevices in the bark or wood. The larva is an elongate, depressed grub having

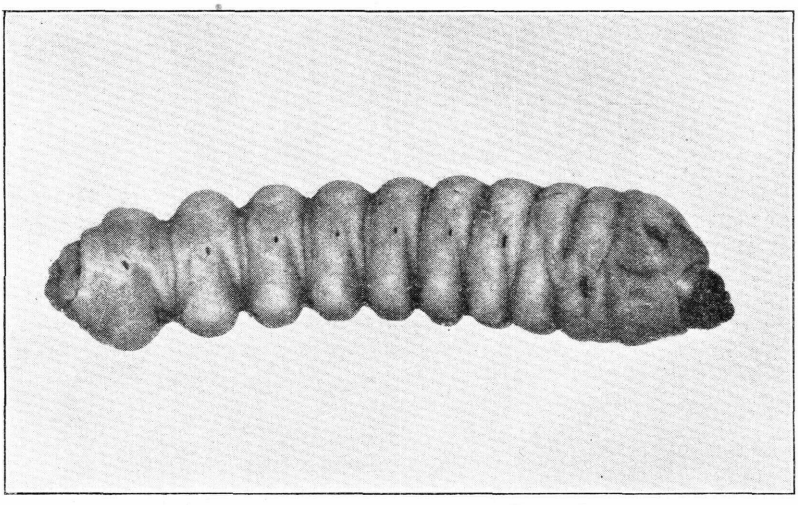

FIGURE 17.—Larva or grub of a roundheaded borer, *Megacyllene antennatus* (white). Enlarged 3 diameters.

a characteristic flat head often wider than the rest of the body (fig. 22). The young borer mines the inner bark or the wood, making a flattened, oval, more or less tortuous mine or wormhole which, when completed, widens into a large pupal or resting cell. This connects with the outer surface by a short, oval exit hole through which the new beetle emerges after the larva has transformed and matured in the pupal cell. The

larval mines may be in either the bark or wood alone, or, as in many instances, extend throughout the entire piece,[12] and are filled with tightly packed sawdustlike material (fig. 23).

SEASONAL ACTIVITY OF THE INSECTS

Some, at least, of the insects of the kinds previously mentioned are at work during the entire growing season, which lasts from April to October in the vicinity of Washington, D. C., from February to December in the extreme Southern States, and from May to September in the Northeastern States. During this time beetles are active, looking for favorable woods on which to lay their eggs. During the rest of the year, however, certain species of these insects are relatively inactive and only a very few or no adult beetles are present.

The bark beetles and ambrosia beetles are active throughout nearly the entire period within the months specified although their numbers vary a great deal within the season of activity. Insects of both the bark-beetle and ambrosia-beetle types mature very rapidly and can develop from the egg to the adult stage in from 4 to 6 weeks. They may have as many as three and often five generations a year in certain parts of the South.

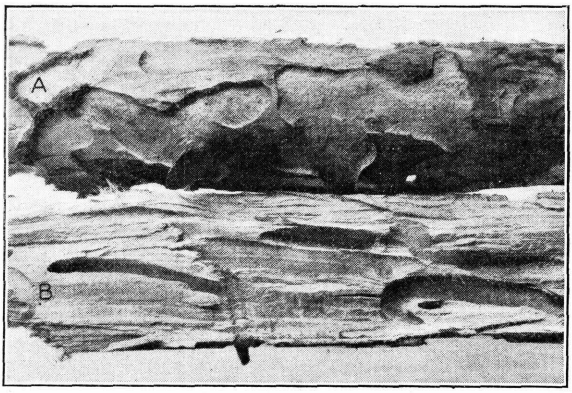

FIGURE 18.—Larval mining of a roundheaded borer, *Callidium antennatum*, which causes the bark to fall off: A, outside of the piece; B, inner mines of the borer. One-half natural size.

The wood borers are not active for so long a period during the season as are the other two classes of beetles and do not multiply so rapidly. Many of them have one generation a year, and others have only one every 2 years.

The powder-post beetle that is most destructive flies in the vicinity of Washington, D. C., mainly from the early part of May to the middle of June, the maximum emergence taking place between May 30 and June 8. Occasionally a partial second generation occurs, and a few beetles emerge during the warm days of late summer and fall and may be seen in flight from August 15 until cold weather comes. The main brood survive the winter in the mature larval stage and do not emerge as beetles until the following May. Seasonal differences affect the earliness or lateness of the flight period. During the hottest part of the summer it is possible for the beetles to develop from eggs in from 60 to 70 days.

The beetles of the roundheaded borers usually fly only a few weeks during the spring and summer months, in the vicinity of Washing-

[12] For further and more detailed information, see BURKE, H. E. FLAT-HEADED BORERS AFFECTING FOREST TREES IN THE UNITED STATES. U. S. Dept. Agr. Bull. 437, 8 p., illus. 1917. Out of print; may be consulted in libraries.

ton, D. C., where they have only one generation a year. Farther south some species have two generations and sometimes a partial third.

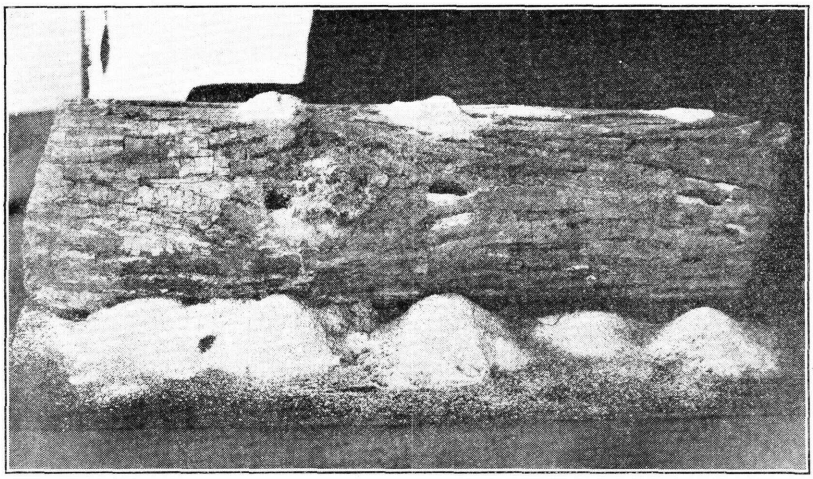

FIGURE 19.—Boring dust exuded by the grub of *Cyllene caryae* as it mined in the sapwood of hickory. About one-sixth natural size.

The flatheaded borers, as beetles, fly about the same time that those of the roundheaded borers appear. Some species mature in a year; others take as long as 2 years.

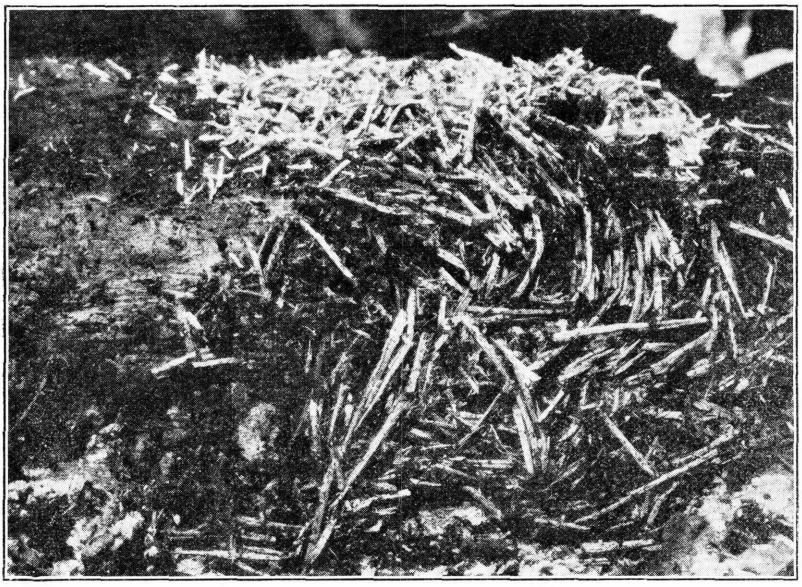

FIGURE 20.—Coarse shredded frass made by the grubs of the southern pine sawyer, *Monochamus titillator*, a roundheaded borer. Enlarged about 2 diameters.

CONDITIONS FAVORABLE AND UNFAVORABLE FOR ATTACK

The kind and condition of wood attacked are largely dependent upon the species of insect. Some species prefer freshly cut wood that is in a moist condition, others partly seasoned wood, and still others require wood that is dry and well seasoned.

CONDITIONS FAVORABLE FOR BARK BEETLES AND AMBROSIA BEETLES

Two types of insects, the bark beetles and the ambrosia beetles, attack freshly cut logs on which the bark remains and in which the inner bark is still white and active and the sap is still present. The ambrosia beetles, however, like equally well logs, with or without bark, that have been submerged in water and which after being removed from the water remain in a moist condition, as when they are placed on the ground in the shade. Such logs may continue to be attacked until they dry out. Wood that is cut during the spring and summer months, when the weather is warm and damp, may be subject to severe injury, especially when placed in close piles on the ground so that it does not receive adequate ventilation. Wood which is cut in the early fall and dried out, or seasoned sufficiently during the winter months, is in an unfavorable condition for attack by bark beetles and ambrosia beetles when their active season arrives.

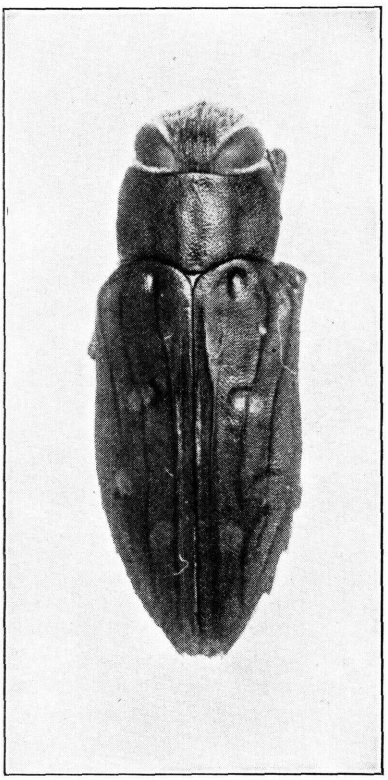

FIGURE 21.—Adult beetle of a flatheaded borer, *Chrysobothris octocola* (Lec.). Enlarged 4 diameters.

CONDITIONS FAVORABLE FOR POWDER-POST BEETLES

The powder-post beetles prefer wood that has been cut several months. They show a decided preference for wood that is cut either in the fall and slowly seasoned over winter, or that which is cut during the active season and dried rapidly. Occasionally they attack recently cut wood, but as a rule they are unsuccessful in establishing themselves in it.

CONDITIONS FAVORABLE FOR ROUNDHEADED BORERS AND FLATHEADED BORERS

Conditions that invite attack by roundheaded and flatheaded borers vary considerably. Many borers prefer recently cut logs, whereas other borers attack logs which have been seasoned for several months. The manner of handling the logs after they are cut has a decided

influence upon whether they will ultimately be attacked. As each species of these beetles flies and lays its eggs during only a short period, and as each kind attacks only one or two kinds of wood, which must be in just the right condition to attract it, the danger of attack by any particular kind is relatively small.

PREVENTIVE AND CONTROL MEASURES

Methods of preventing insect attack and the checking of subsequent injury, once the log is infested, depend largely upon the seasonal history and habits of the insects involved. By taking advantage of what is known of these, the desired protection can be obtained.

PREVENTION OF ATTACK

SEASONAL CUTTING FOR RUSTIC STRUCTURES

The logs with the bark remaining on them and poles used in the construction of rustic cabins, summer houses, fences, etc., should be cut in October or November and piled at once,[13] either off the ground or under cover, so that the inner bark may dry rapidly and thoroughly before the beetles begin to fly in the spring.[14] Slabs with bark on the outside, to be used over wooden frames, should be handled as green

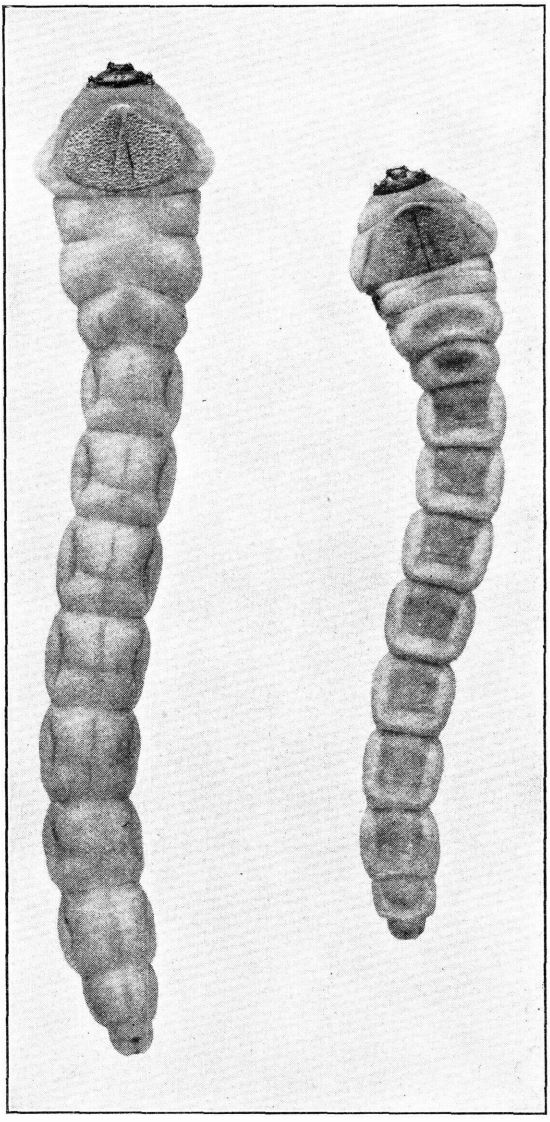

FIGURE 22.—Grubs of the flatheaded borer *Chalcophora angulicollis* (Lec.). Enlarged 2 diameters.

[13] Juniper or cedar trees can be felled during August with very little danger of attack if the tops are removed and the poles are laid singly on the ground and turned over once a week for about 3 weeks to expose a fresh surface to the sun.

[14] HOPKINS, A. D. INSECT INJURIES TO FOREST PRODUCTS. U. S. Dept. Agr., Bur. Ent. Circ. 128, 9 p. 1910. Out of print; may be consulted in libraries.

logs are handled. This will almost surely prevent damage by the insects that prefer freshly cut wood.[15] The date of cutting given is for the vicinity of Washington, D. C.

FOR MANUFACTURED PRODUCTS

Poles to be used in rustic furniture, shuttle blocks, mallets, and mauls should be cut in the late fall and winter and either utilized before the first flight of beetles in the spring or placed under closed cover. It may be necessary to screen them, using screen cloth having 18 meshes to the inch. If poles must be cut in spring or summer they should be removed from the forest as fast as they are cut, and utilized at once. If they are exposed in the forest for a few days at this time insect infestation may occur, but develop only after the wood had been manufactured (fig. 12). If the poles cannot be removed at once, spraying them with a solution of kerosene and creosote, as hereafter described, will protect them for a few days.

Waste material on which the bark remains, if left about the factory yards while insects are active, may serve as a breeding place for them.

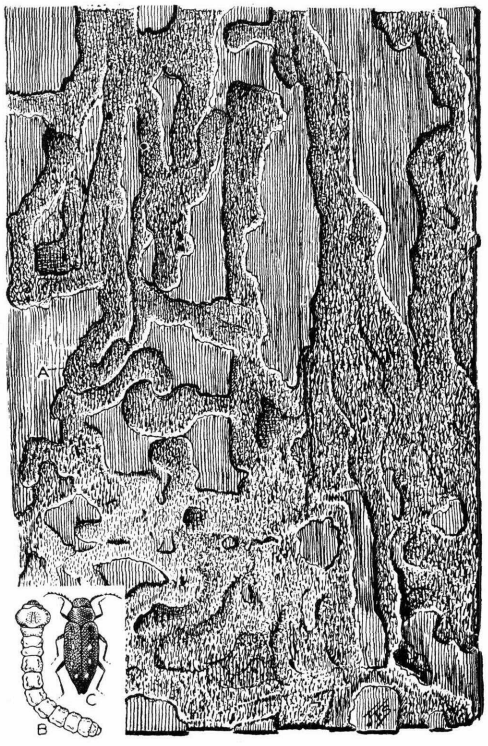

FIGURE 23.—Work of the flatheaded eastern hemlock bark borer, *Melanophila fulvoguttata* (Harr.). A, section of hemlock bark showing larval mines in the inner portion, one-half natural size; B, larva; C, adult, natural size. (Burke.)

CHEMICAL TREATMENTS

If it is desired to retain the bark on poles, they may be protected from insects either by treating the surface of the green or partly seasoned logs with a repellant chemical or by injecting into the wood of a living tree a suitable preservative before cutting up the trunk.

Surface treatments.—Certain powder-post[16] and roundheaded[17] borers cannot be readily controlled by seasonal cutting and seasoning methods, and to obtain the maximum protection the wood used in

[15] For information on prevention of end checking of logs during seasoning, see TEESDALE, L. V. THE CONTROL OF STAIN, DECAY, AND OTHER SEASONING DEFECTS IN RED GUM. U. S. Dept. Agr. Dept. Circ. 421, 18 p., illus. 1927. Out of print.

[16] *Xylobiops basilaris.*

[17] *Callidium antennatum* in pine, *Callidium janthinum* (Lec.) in cedar, and *Chion cinctus* in hickory and oak.

the construction of rustic cabins, summer houses, etc., should be treated in the spring with coal-tar creosote before the beetles begin to fly. Better penetration of the liquid is obtained when it is diluted with three parts of kerosene.

How to use the creosote-kerosene mixture.—Wood can be treated easily and effectively by immersing the log in a quantity of the chemical in a trough of sheet metal, such as galvanized iron. With a short length of rope fitted under the log, it is easy to roll it (fig. 24) so that the mixture will penetrate all cracks and crevices. After the log has been thoroughly wet it should be laid in a sunny place to dry. In a log thus exposed to the sun the mixture penetrates the wood better than in one that is shaded.

FIGURE 24.—Rolling a log in a trough of creosote and kerosene.

If the immersion method is impractical, the chemical can be applied to the surface of the log with a sprayer or brush.

Whenever it is necessary, during the spring and summer months while the insects are active, to cut trees whose bark is to be retained on the poles, the logs should be treated, as soon as cut, with the creosote-kerosene mixture. Where a slight staining of the wood is objectionable, the same protection can be obtained by carefully removing the bark in sections, applying the solutions to the sapwood, and then replacing the bark, using large-headed nails to fasten the bark in place. One nail to each square foot is usually sufficient for this purpose. Coal-tar creosote (grade 1, liquid oil) is a dark-brown liquid that stains the bark deeply when applied full strength. When diluted with three parts of kerosene, however, the bark is stained only slightly, and this gives a rather pleasing effect. The odor is not very strong when the creosote is diluted with kerosene. Before it is used as a spray, it should be strained through burlap. Only grade No. 1 should be used; otherwise the wood may be stained darker than is desired.

Tree-injection method.—The tree-injection method consists of impregnating the wood and inner bark of standing trees with a toxic preservative which will protect them from subsequent attack by bark-infesting insects and wood-destroying fungi. Such a method is simple and economical and makes possible the use of species of trees which otherwise would be unsuitable on account of their short service when exposed to the weather or placed in contact with or near the ground. The simplest way to impregnate a tree with a chemical is to fasten the top of the tree securely to one nearby and then cut the trunk at a convenient height so that it can easily be lowered into a container placed beside it, into which the quantity of chemical indicated in table 1 is then put. Such technique is frequently referred to as the "stepping" method (fig. 25) and is naturally limited in its use by the manpower or equipment available. Aqueous solutions of metallic salts, such as copper sulfate or zinc chloride,[18] are readily absorbed from the containers overnight during the active growing season.[19] Usually the preservative is well distributed throughout the tree in about 10 days.[20] The tree can then be lowered and the trunk trimmed and converted into poles of the desired length, care being taken in handling the logs not to bruise the bark and mar the rustic effect. The quantity of

FIGURE 25.—A tree "stepped" down into a tub of metallic salts solution to allow the chemical to go through the circulatory channels to all parts of the tree.

[18] These chemicals have a corrosive action on metal containers, especially tin; therefore buckets made of wood, agateware, or enameled metal should be used.

[19] Occasionally an abnormal quantity of resin will form and cover the cut surface, thereby hindering the absorption of the chemical. In such a case a slice of wood about 1 inch thick may have to be removed from the lower end of the log. Another way of preventing excessive pitch formation on the cut is to girdle the tree, below the place where it is to be severed, a day before the cutting.

[20] For further information concerning this and other methods of injection and preservation of wood see the following mimeographed briefs:

CRAIGHEAD, F. C., ST. GEORGE, R. A., and WILFORD, B. H. A METHOD FOR PREVENTING INSECT INJURY TO MATERIAL USED FOR POSTS, POLES, AND RUSTIC CONSTRUCTION. U. S. Bur. Ent. and Plant Quar. Cir. E–409, 7 pp., illus. 1937. [Mimeographed.]

LANTZ, A. E. AN EFFICIENT METHOD FOR INTRODUCING LIQUID CHEMICALS INTO LIVING TREES. U. S. Bur. Ent. and Plant Quar. Cir. E–434, 4 pp., illus. 1938. [Mimeographed.]

HUNT, GEORGE M., and WIRKA, R. M. TIRE-TUBE METHOD OF FENCE POST TREATMENT. U. S. Forest Serv., Forest Prod. Lab., Madison, Wis., 9 pp., illus 1938. Revised by Wirka in 1940 [Mimeographed.]

WIRKA, R. M. PRESERVATION OF TIMBER BY THE STEEPING PROCESS. U. S. Forest Serv., Forest Prod. Lab., Madison, Wis., 9 pp., illus. 1939. [Mimeographed.]

chemical needed to treat trees of various sizes can be determined by consulting table 1.[21]

TABLE 1.—*Recommended dosages (in pounds of chemical[1] and gallons of water) to use for medicating shortleaf pines of various heights and diameters*

Diameter of tree at breast height (inches)	Dosages for trees of the heights indicated in feet									
	20		30		40		50		60	
	Chemical	Water	Chemical	Water	Chemical	Water	Chemical	Water	Chemical	Water
	Pounds	*Gallons*	*Pounds*	*Gallons*	*Pounds*	*Gallons*	*Pounds*	*Gallons*	*Pounds*	*Gallons*
3			½	¼	¾	½	1	½	1	½
4	½	¼	1	½	1¼	½	1½	½	1¾	¾
5	¾	½	1½	½	1¾	¾	2¼	1	2¾	1¼
6			1¾	¾	2¼	1	3	1½	3¾	1¾
7			2	1	2¾	1¼	3¾	1¾	4¾	2¼
8			2¼	1	3¼	1½	4¼	2¼	5½	2½
9			2½	1¼	3¾	1¾	5	2½	6¼	3
10			3	1½	4½	2¼	5¾	2¾	7¼	3
11			3½	1½	5	2½	6¼	3	8¼	3¾
12			4	2	5½	2½	7	3	9½	4

Diameter of tree at breast height (inches)	Dosages for trees of the heights indicated in feet									
	70		80		90		100		110	
	Chemical	Water	Chemical	Water	Chemical	Water	Chemical	Water	Chemical	Water
	Pounds	*Gallons*	*Pounds*	*Gallons*	*Pounds*	*Gallons*	*Pounds*	*Gallons*	*Pounds*	*Gallons*
3										
4	2	1								
5	3¼	1½								
6	4½	2¼	5½	2½	6¼	3				
7	5½	2½	6¼	3	7	3				
8	6½	3	7¼	3	8	3¾				
9	7½	3¼	8½	3¾	9½	4				
10	8½	3¾	10	4¼	11¼	5	13½	5½		
11	9¾	4¼	11½	5	13	5½	15	6½		
12	11	5	13½	5½	15	6½	17	7½	19	8½

[1] Copper sulfate or zinc chloride. A list of companies handling these chemicals will be furnished upon request.

PEELING THE POLES

If it is not especially desirable to retain the bark, a very pleasing effect can be obtained by peeling the poles and treating them with creosote and kerosene in the proportions previously suggested. The slight stain thus given is just deep enough to give to a cabin a rustic effect, which usually is agreeable. Such treatment aids in preserving the wood. In certain localities peeling the poles and logs is popular. The peeled poles, however, should be kept off the ground for several days or until they have had a chance partially to season so that they will not be attractive to pinhole borers. Peeled poles thus seasoned will not need treatment with chemicals to protect them from insects that attack green or partially seasoned wood.

[21] Although this table is based on shortleaf pine, it is believed that it will serve in a general way for many other species used for rustic purposes.

TREATMENT AFTER ATTACK

KILLING THE INSECTS WITH CHEMICALS

Both liquid orthodichlorobenzene and crystalline paradichlorobenzene are effective agents for killing insects that have already attacked wood.[22] Both these chemicals slowly liberate a gas that is fatal to insects.

Orthodichlorobenzene.—Commercial orthodichlorobenzene[23] is a colorless, stainless liquid, possessing an odor that persists for several days. It is noninflammable, but it is slightly poisonous, and the odor might cause a headache if the liquid were handled for an hour or so at a time. Because of this, logs or furniture should be treated in the open some distance from any dwelling. If it is necessary to apply this chemical inside a building, the doors and windows should be opened so as to allow ample ventilation. A windy day is preferable. Reasonable care should be taken in handling, especially where the wood treated is overhead (rafters, etc.), since the liquid dripping down might burn the skin slightly and be especially painful if it came in contact with the eyes. To avoid this, the workers should provide themselves with goggles, rubber gloves, etc. This chemical can be applied full strength or diluted with 8 parts of fuel oil, especially when treating logs. The addition of 6 ounces of naphthalene flakes per gallon of mixture increases its toxicity. Orthodichlorobenzene is very penetrating. When it is used on a finished product that has been polished, the surface coating (varnish, shellac, etc.) may be marred. It can be refinished, however, at a later date.

The following formula was developed in England for use in treating beetle-infested wood in old buildings:

Material:	*Percent*
Orthodichlorobenzene	50
Kerosene	47
Barium oleate	3

Paradichlorobenzene.—Paradichlorobenzene was found most effective when dissolved in three parts, by weight, of kerosene. Care should be taken to dissolve all the crystals. It is noninflammable and only slightly poisonous. This chemical, like orthodichlorobenzene, may destroy the finish on furniture and necessitate revarnishing. If the infested wood is not treated, however, it may eventually be destroyed.

Turpentine and kerosene.—A mixture composed of nine parts turpentine to one of kerosene is recommended in England for this pur-

[22] Paradichlorobenzene and the crude orthodichlorobenzene product are manufactured by only a few chemical firms. Names and addresses of these firms will be furnished on application to the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

[23] The chemical purchased under the name orthodichlorobeneze (also called orthodichlorbenzol, orthene, and ODB) and tested as such against insect attack is mainly a liquid that might be called a crude chlorinated benzol product and is not the chemically pure orthodichlorobenzene. The commercial or crude product is manufatured by several concerns, each using its own method, and is being sold under different trade names. It is usually composed largely of monochlorobenzene and ortho-, meta-, and paradichlorobenzene products, with the greater part orthodichlorobenzene. The chemically pure orthodichlorobenzene is manufactured in limited quantities at the present time and is too expensive to be used for this purpose.

pose and the claim is made for it that it will not mar the finish on wood. Although the Department of Agriculture has not checked these results thoroughly, the findings to date substantiate them.

Wood in use can be conveniently treated by applying a liberal quantity of one of the foregoing chemicals either with a good spraying apparatus or with a brush. To insure the best results, it is important to treat thoroughly all parts of the wood. One gallon of any of the recommended solutions is sufficient to treat five logs, each 10 feet long and 4 inches in diameter, or approximately 50 square feet of bark surface. Two gallons will saturate approximately 100 square feet of wood surface. A pint is usually sufficient to treat a rustic chair of ordinary size.

KILLING THE INSECTS WITH HEAT

In the manufacture of rustic furniture it is customary to steam the wood prior to bending it, especially the older pieces of small-dimension hickory. Often the material is found to be infested by borers, and it is usually supposed that by leaving the wood in water, through which steam is being passed, for a period of 15 to 30 minutes the borers will be killed. An examination of material in a factory where the foregoing method was used in the manufacture of rustic furniture from hickory demonstrated that only a very small percentage of the grubs are killed in this short period of time.

Results of tests [24] have shown that in order to kill all the grubs in wood 1 inch thick it is necessary to subject infested hickory and ash to kiln temperatures of 125° to 130° F. for a minimum period of 1½ to 2 hours.

R. C. Fisher,[25] in verifying the foregoing recommendations for the control of *Lyctus* beetles, determined the period of time necessary for infested ash or oak of various thicknesses to reach this temperature when placed in a kiln. For safety the wood should be left in the kiln somewhat longer, and then subjected to live steam for 1½ or 2 hours in a saturated atmosphere. Parkin [26] extended Fisher's work to include relatively low temperatures and humidities. The time of treatment covering the work of both these investigators is shown in table 2.

Steaming under high pressure may weaken and discolor the wood and should not be applied to wood to be used for fine finish or where great structural strength is essential. The humidity should be at the saturation point.

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[24] CRAIGHEAD, F. C., and LOUGHBOROUGH, W. K. TEMPERATURES FATAL TO LARVAE OF THE RED-HEADED ASH BORER AS APPLICABLE TO COMMERCIAL KILN DRYING. Jour. Forestry 19: 250–254. 1921.

SNYDER, T. E., and ST. GEORGE, R. A. DETERMINATION OF TEMPERATURES FATAL TO THE POWDER-POST BEETLE LYCTUS PLANICOLLIS LE-CONTE, BY STEAMING INFESTED ASH AND OAK LUMBER IN A KILN. Jour. Agr. Res. 28: 1033–1038, illus. 1924.

[25] FISHER, RONALD C. LYCTUS POWDER-POST BEETLES. [Gt. Brit.] Dept. Sci. and Indus. Res., Forest Prod. Res. Bul. 2, 46 pp., illus. 1929.

[26] PARKIN, E. A. THE KILN STERILIZATION OF TIMBER INFESTED BY LYCTUS POWDER-POST BEETLES. Forestry 11: [32]–39. 1937.

TABLE 2.—*Schedule for treating wood to check damage by powder-post beetles*

Relative humidity (percent)	Lethal temperature required	Thickness of timber	Time required to overcome lag after kiln has attained lethal temperature	Additional margin of safety	Time then held at lethal temperature	Total period of exposure after kiln has attained required conditions
	°F.	Inches	Hours	Hours	Hours	Hours
100	130	1	½	½	1½	2½
		2	2	½	1½	4
		2½	3¼	½	1½	5¼
		3	4½	½	1½	6½
	125	1	½	½	2	3
		2	2	½	2	4½
		2½	3¼	½	2	5¾
		3	4½	½	2	7
80	120	1	½	1½	6	8
		2	2	1½	6	9½
		2½	3¼	1½	6	10¾
		3	4½	1½	6	12
	115	1	½	7½	30	38
		2	2	7½	30	39½
		2½	3¼	7½	30	40¾
		3	4½	7½	30	42½
60	125	1	½	1	4	5½
		2	2	1	4	7
		2½	3¼	1	4	8¼
		3	4½	1	4	9½
	120	1	½	2	7	9½
		2	2	2	7	11
		2½	3¼	2	7	12¼
		3	4½	2	7	13½
	115	1	½	9	36	45½
		2	2	9	36	47
		2½	3¼	9	36	48¼
		3	4½	9	36	49½

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